NASA Jet Propulsion Laboratory Green Feasibility Evaluation

Steven Slaten, NASA Remedial Project Manager

Keith Fields, Battelle Project Manager

Presentation Summary

(1) Background

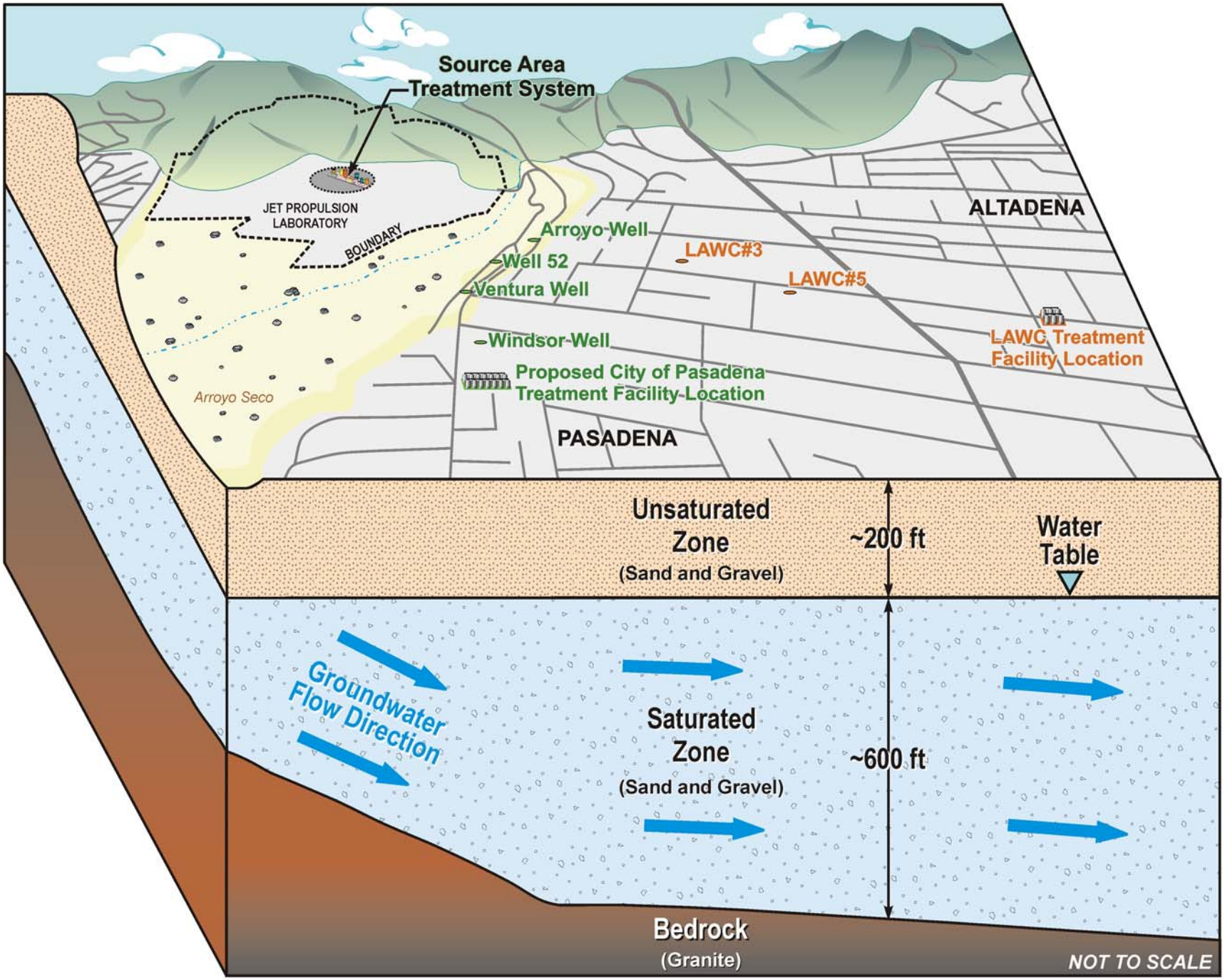
(2) Results and Discussion (Energy Efficiency, Renewable Energy, Water Efficiency, and Green Construction)

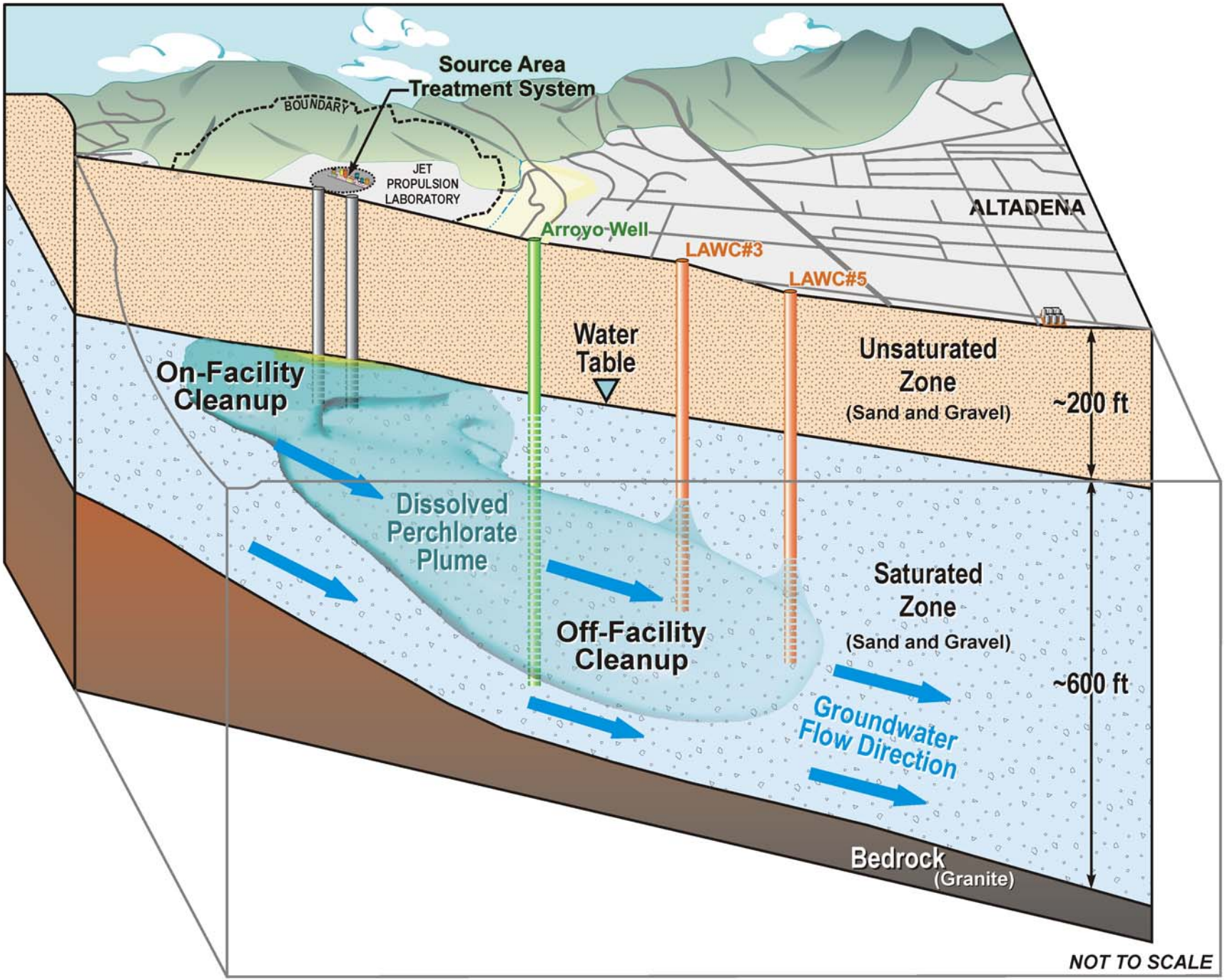
(3) Conclusions

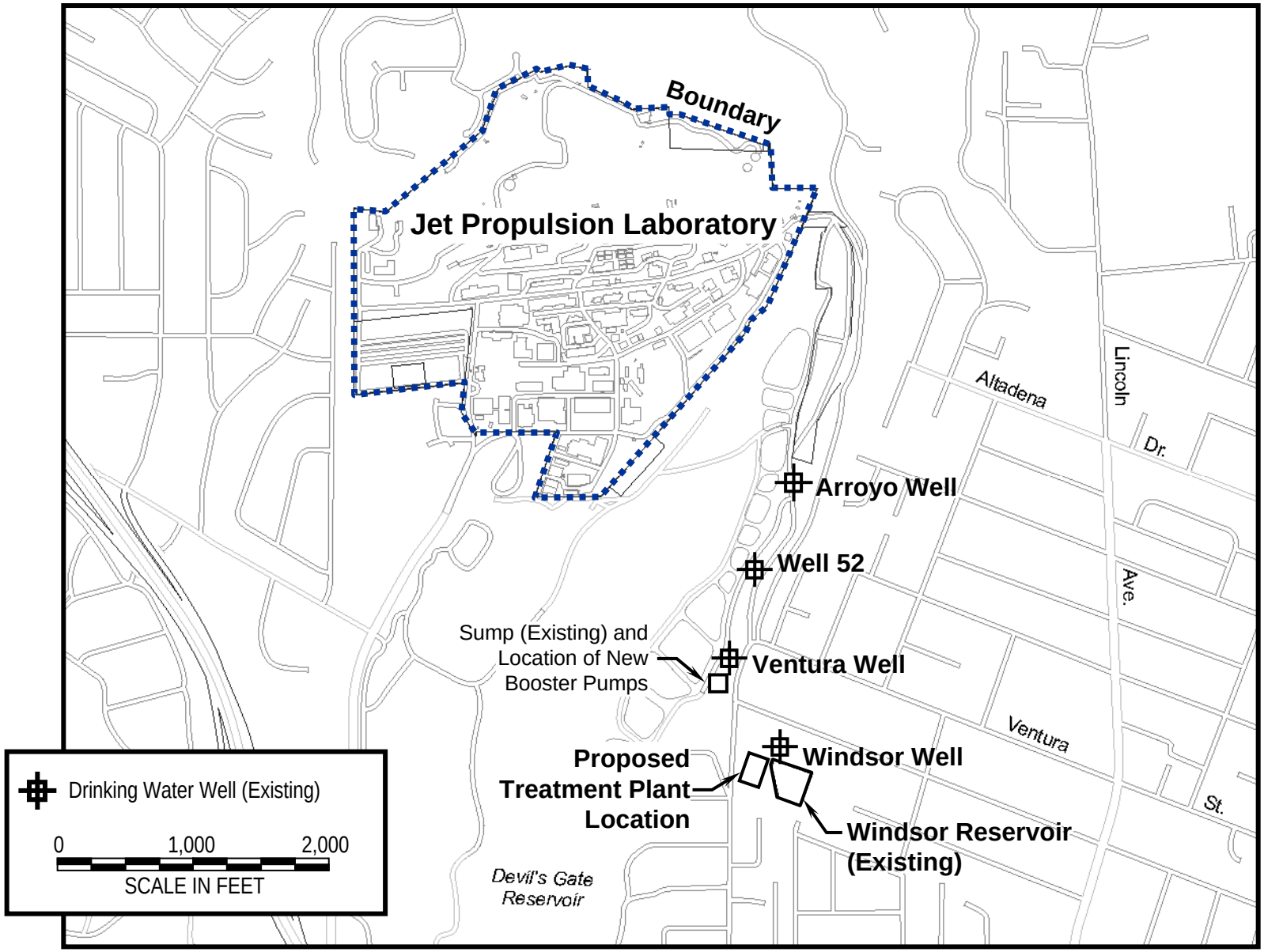
"In the LA Basin alone, we have approximately 6% of California's habitable land but only 0.06% of the State's stream flow -- yet we hold over 45% of the State's population."
… Martha Davis - UCLA Environment Symposium, March 3, 1998

"Energy is the single most important technological challenge facing humanity today."
… Nathan Lewis – Caltech California Clean Innovation Conference, May 11, 2007

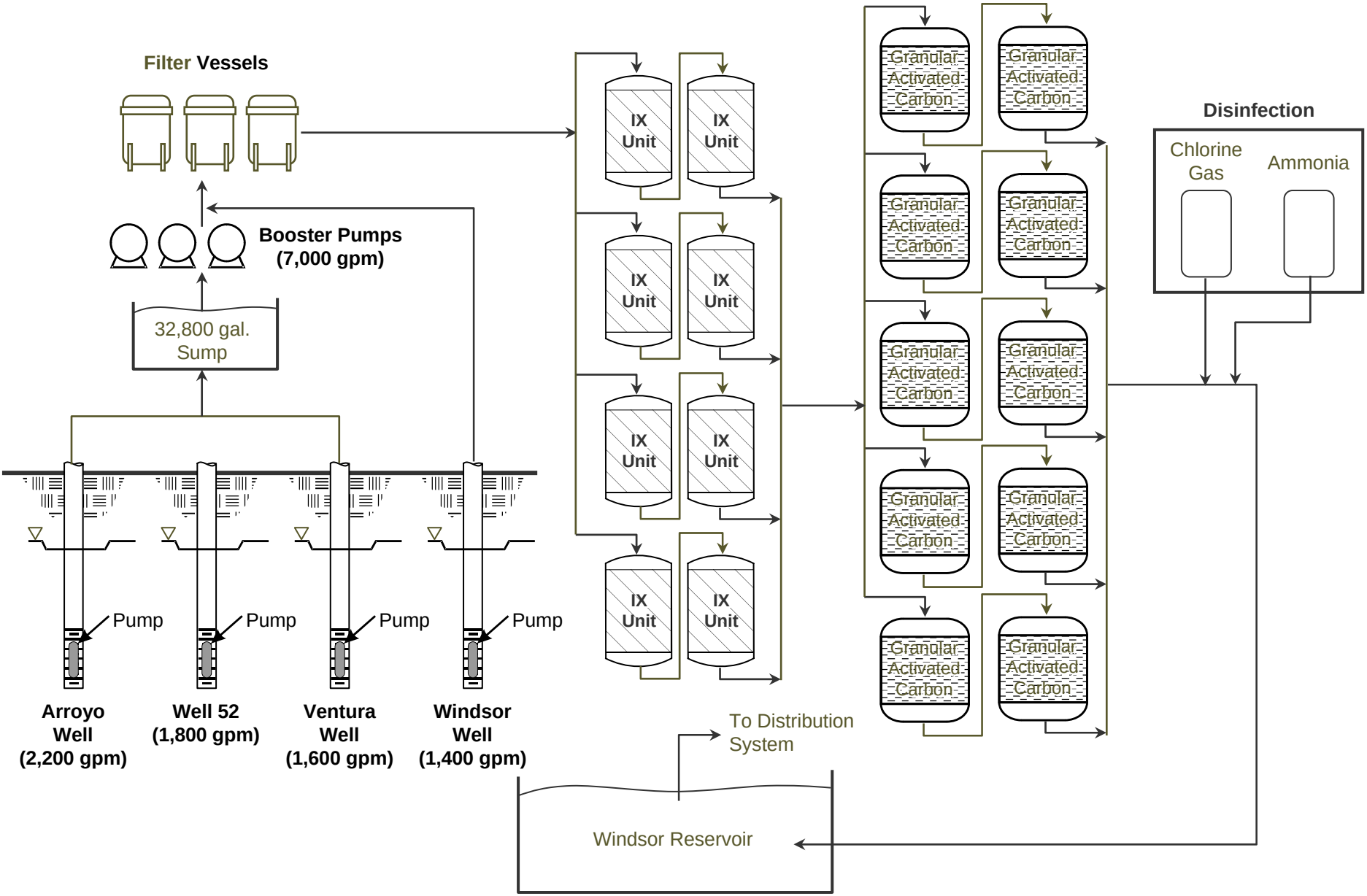
"Buildings account for 1/6th of the world's fresh water withdrawals, 1/4th of its wood harvest, and 2/5ths of its material and energy flows"
…*A Building Revolution: How Ecology and Health Concerns are Transforming Construction.*

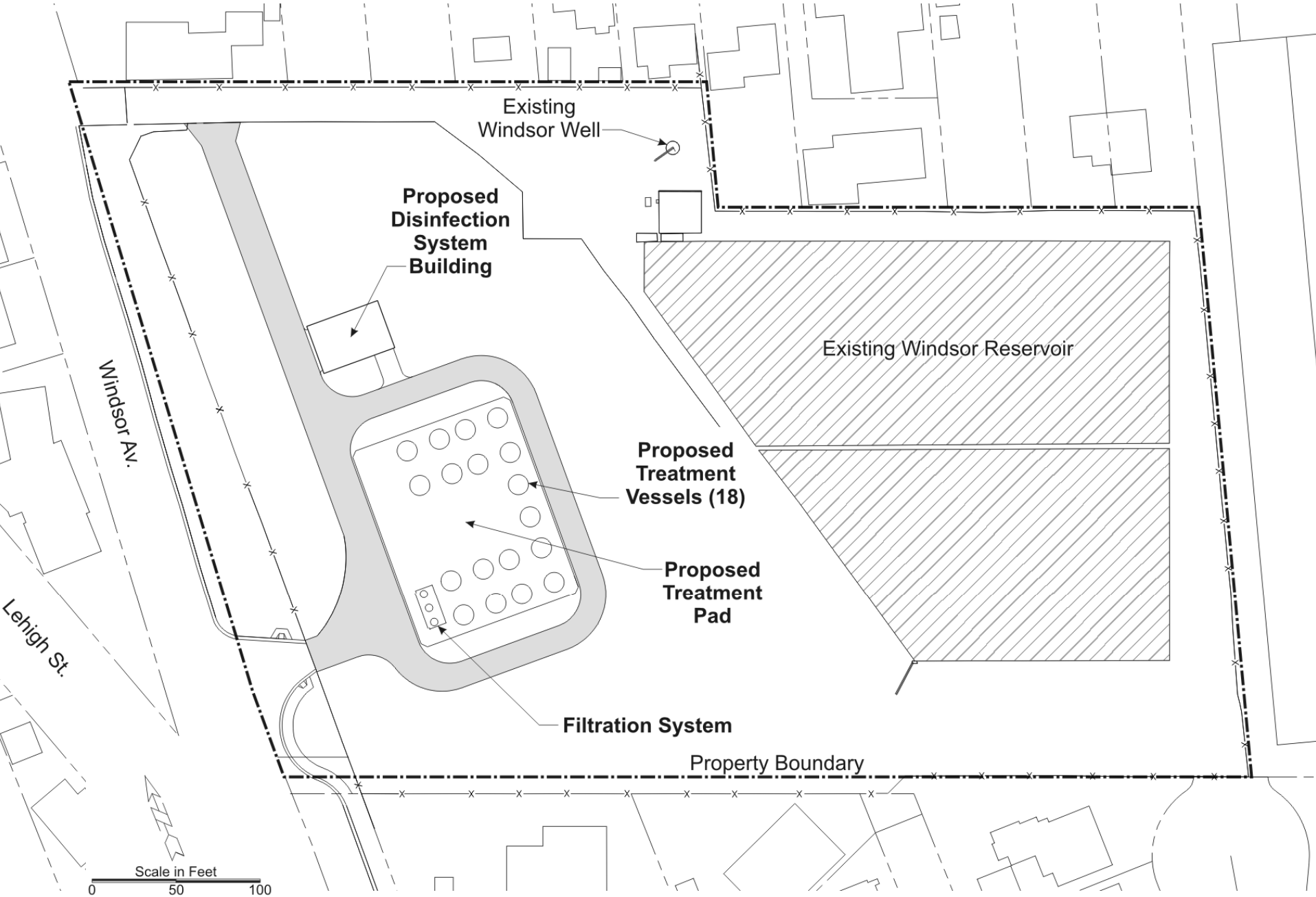

Source Area
Treatment System
JET PROPULSION
LABORATORY
BOUNDARY
Arroyo Seco
Arroyo Well
Well 52
Ventura Well
Windsor Well
Proposed City of Pasadena
Treatment Facility Location
ALTADENA
LAWC#3
LAWC#5
LAWC Treatment
Facility Location
PASADENA
Unsaturated
Zone
(Sand and Gravel)
~200 ft
Water
Table
Groundwater
Flow Direction
Saturated
Zone
(Sand and Gravel)
~600 ft
Bedrock
(Granite)
NOT TO SCALE


Source Area
Treatment System
BOUNDARY
JET
PROPULSION
LABORATORY
ALTADENA
Arroyo Well
LAWC#3
LAWC#5
Water
Table
On-Facility
Cleanup
Unsaturated
Zone
(Sand and Gravel)
~200 ft
Dissolved
Perchlorate
Plume
Saturated
Zone
(Sand and Gravel)
Off-Facility
Cleanup
~600 ft
Groundwater
Flow Direction
Bedrock
(Granite)
NOT TO SCALE


Boundary
Jet Propulsion Laboratory
Arroyo Well
Well 52
Sump (Existing) and
Location of New
Booster Pumps
Ventura Well
Windsor Well
Proposed
Treatment Plant
Location
Windsor Reservoir
(Existing)
Devil's Gate
Reservoir
Altadena
Lincoln
Dr.
Ave.
Ventura
St.
Drinking Water Well (Existing)
0
1,000
2,000
SCALE IN FEET

Monk Hill Treatment System - PFD




Existing
Windsor Well
Proposed
Disinfection
System
Building
Existing Windsor Reservoir
Windsor Av.
Proposed
Treatment
Vessels (18)
Proposed
Treatment
Pad
Lehigh St.
Filtration System
Property Boundary
Scale in Feet
0
50
100

Green Feasibility Evaluation for the MHTS at JPL

- Goal of the evaluation was to identify opportunities to execute the project in the most effective manner over its lifecycle, recognizing the importance of cost and sustainable environmental stewardship.
- Evaluation structured to address goals identified in Executive Order 13423, including:
  - » Improving Energy Efficiency and Reducing Greenhouse Gas Emissions
  - » Ensuring that New Renewable Energy Sources are Identified and Implemented, Where Feasible
  - » Reducing Water Consumption Intensity
  - » Acquiring Goods and Services that Use Sustainable Environmental Practices
  - » Ensuring the New Construction of Agency Buildings Comply with the *Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings set forth in the Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding*
- **Contractor Incentive** - added a clause to the Prime Contract, making available 1% of the contract award amount for incentive payments on efforts that support achievement of the goals of EO 13423.

Estimating Energy Usage - Baseline

MHTS Process	Power Requirement (kW)	Power Usage/ Treated Volume (kWh/MG)	GHG Emissions (lbs CO_2/year)
Arroyo Well Pump (150HP)	89.5	213	0.35M
Well 52 Pump (200HP)	105.9	252	0.41M
Ventura Well Pump (150HP)	86.5	206	0.34M
Windsor Well Pump (125HP)	101.3	241	0.39M
Booster Pump No. 1 (350HP)	259.9	619	1.01M
Booster Pump No. 2 (350HP)	259.9	619	1.01M
Total	**903**	**2,150**	**3.51M**

Assumptions and Notes:

- 5,700 ac-ft of water treated per year at 7,000 gpm, resulting in 184 days of operation.
- Motor efficiency of 96% and a pump efficiency of 80%.
- GHG emission factor for electricity generation (zip code 91109) = 879 lbs CO_2/MWh.
- Average energy consumption for water treatment facilities is 1,700 to 1,900 kWh/MG.

Estimating Energy Cost - Baseline

Description	Total Sump ($/Year)	Total Wells ($/Year)
Customer/Meter Charge	$1,923	$2,891
Distribution Charge	$94,255	$69,459
Transmission Charge	$18,591	$13,746
Energy Service Charge		
Summer On-Peak (noon-8PM)	$36,753	$26,626
Summer Off-Peak (8PM to noon)	$68,302	$52,229
Winter On-Peak (6AM-10PM)	$24,727	$18,388
Winter Off-Peak (10PM-6AM)	$23,747	$18,072
Power Cost Adjustment	$23,180	$17,139
Public Benefit Charge	$19,240	$14,226
Annual Total ($543,492)	**$310,718**	**$232,774**

Assumptions and Notes:

- Utilizes current PWP rates (effective October 1, 2007) schedules L-1 and M-1.
- NASA pays energy costs for sump pumps, PWP pays energy costs for production wells.

Improving Energy Efficiency/Reducing GHG – Windsor Well

- Windsor Well originally pumped downhill to the sump located near the Ventura Well (75 ft elevation change).
- Modified approach to pump directly to the MHTS, improving energy efficiency due to reduced elevation change and reduced friction losses in pipelines.
- Increased size of Windsor Well pump, decreased size of sump pumps.

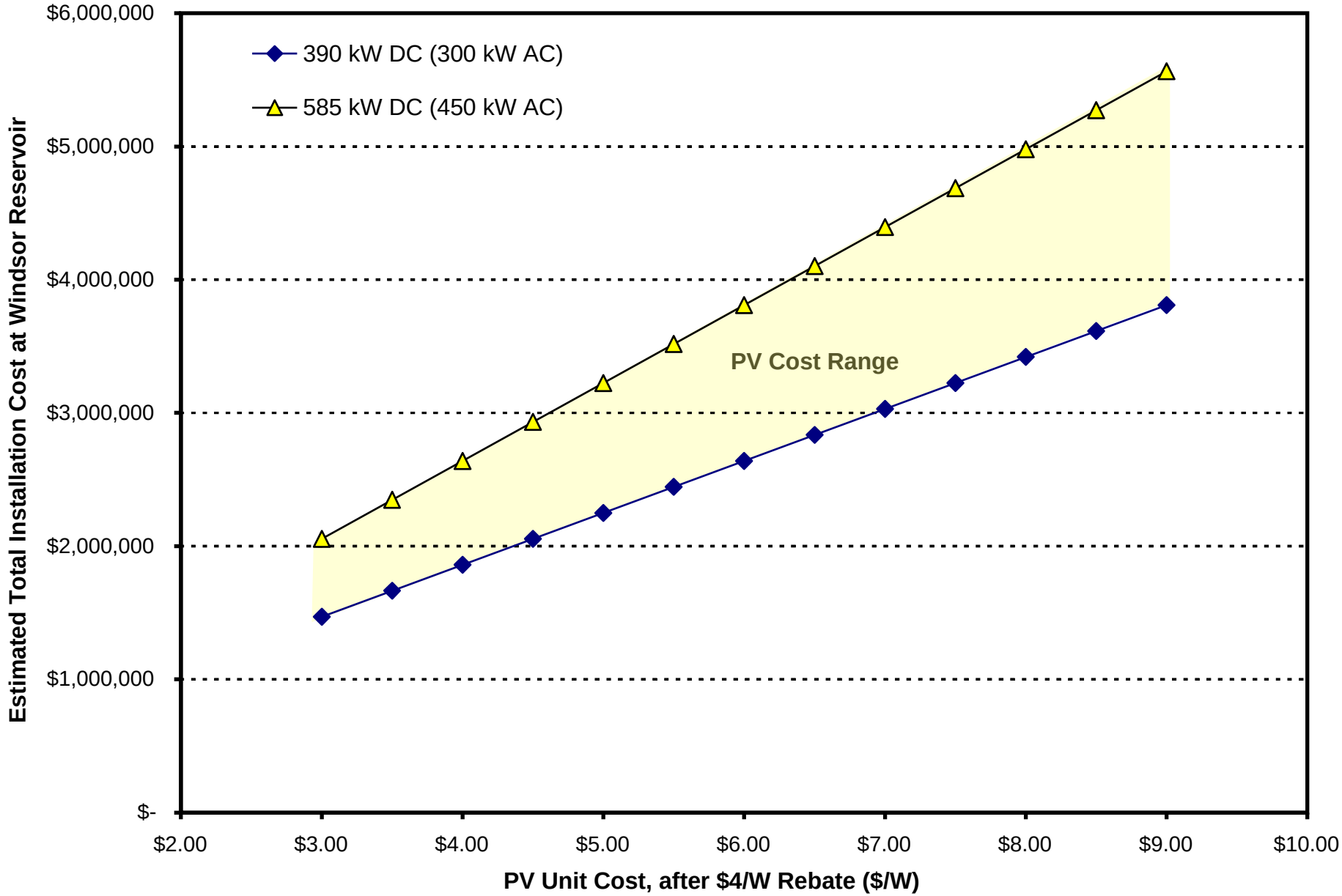
Improving Energy Efficiency/Reducing GHG (Cont.)

- Eliminated Post Filtration
    - » Negotiated with PWP and Calgon to remove post filtration cartridge filters, resulting in approximately $200K capital cost reduction.
    - » Allowed for reduced size of sump pumps and improved energy efficiency.
- High efficiency pumps will be utilized.
- Other Options Evaluated/Considered
    - » Peak Shaving (Reducing Peak Power Draw) and Peak Shifting (Maximizing Energy Use During Off-Peak Times) – Not many options since pumps need to operate continuously to meet Pasadena summer water demands.
    - » Power Emergency Situations - $4/kW-month reduction (could save over $20K/year at the MHTS)
- **Optimized approach resulted in savings of $50,000/year and reducing GHG emissions by 330,000 lbs per year (equivalent to the annual GHC emissions of 27 passenger vehicles).**

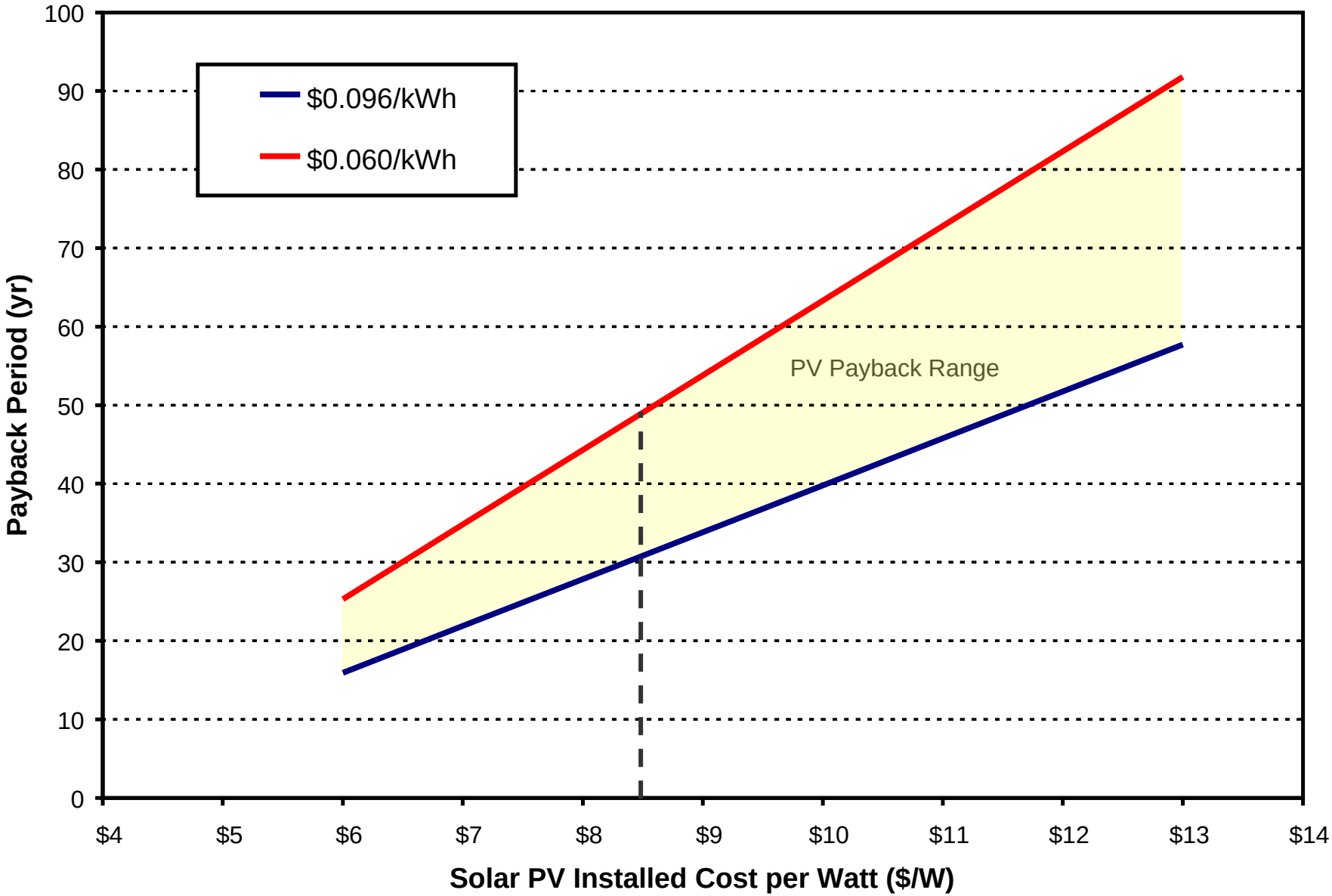
Renewable Energy Options

- Started by evaluating all possible renewable energy options (e.g., wind, hydro, geothermal)
- Identified In-line Microturbine Technology to Install in Pipelines
  - » PWP has a pressure reducing station at the Windsor Reservoir Property
  - » Estimated payback times could be less than 5 years.
- Evaluated the Use of Photovoltaics (PV)
  - » Windsor Reservoir has approximately 58,000 ft^2 of nearly flat roof. PV panels placed on roof would result in a 300kW to 450kW AC system (based on vendor).
  - » PV System Costs Average about $8-$9/W, installed = $3,825,000 for 450kW system.
  - » PWP Incentive Program of $4/W = $1,800,000 for 450kW system.
  - » $300,000 in structural improvements to Windsor Reservoir needed for PV panels.

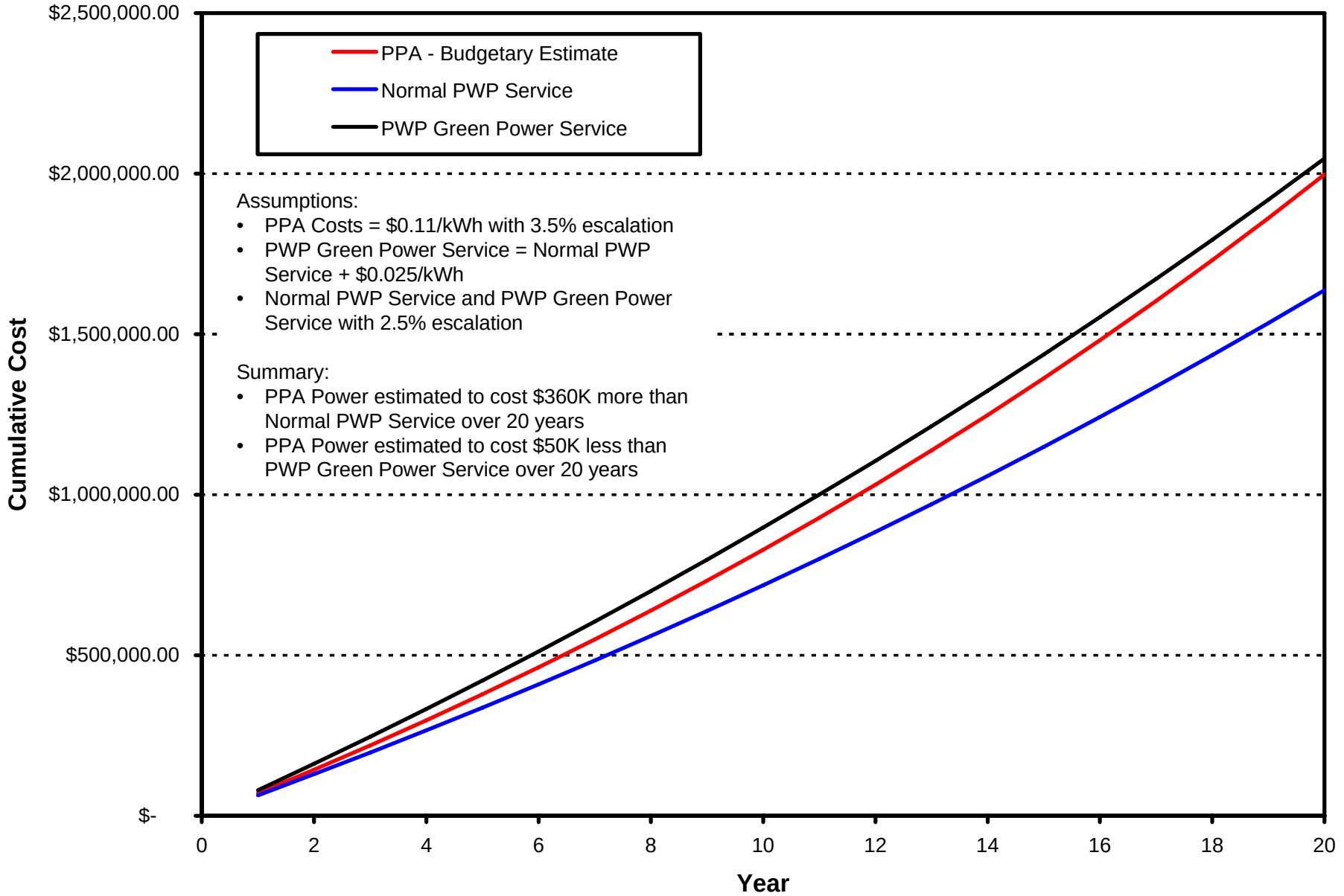
Estimated Total Cost of PV at Windsor Reservoir



Estimated Payback Period for PV at Windsor Reservoir



Power Purchase Agreement (PPA) Evaluation



Renewable Energy Conclusions

- In-line Microturbine Technology
  - » PWP is currently evaluating implementation.
  - » NASA is no longer involved.
- Photovoltaics (PV) at Windsor Reservoir
  - » PWP is moving forward with structural upgrades to Windsor Reservoir that would allow installation of PV panels.
  - » NASA is no longer involved.
- Green Power Service
  - » Can purchase power from PWP generated from renewable energy sources
  - » PWP Green Power Service Charge = 0.025/kWh
  - » If all power for sump pumps purchased under Green Power Service, cost would increase $39K/year

Reducing Water Intensity

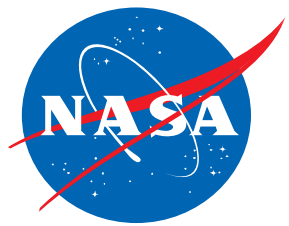
- Landscaping Plan includes native, drought-tolerant species to reduce irrigation requirements.
- Utility Water
    - » Generated during production well development and periodic flushing.
    - » Also, generated during backwashing the ion exchange and activated carbon media.
    - » Estimated that approximately 50 acre-feet of utility water will be generated during well development and approximately 60 acre-feet of utility water will be generated per year during system operation (from periodic flushing and backwashing).
    - » Utility water being treated by the MHTS and then discharged to the Arroyo Seco spreading basins near the Arroyo Well. Will infiltrate back into the aquifer
    - » Value of Water in Basin = $800/ac-ft (may double in the next 10 years)
- No sanitary sewer discharges associated with MHTS

Green Construction

- Evaluated green construction, including the use of acquiring goods and services that use sustainable environmental practices.
- Utilized LEED Green Building Rating System as a framework for evaluating green construction. LEED certification for this type of construction does not currently exist.
- Key green construction activities:
  - » Stormwater management plan developed to reduce volume and improve quality of stormwater runoff through landscaping (vegetated filter strip), and regular maintenance.
  - » Outdoor lighting will be controlled by photo sensing and programmable time switches and achieve a lighting efficiency of greater than 60 lumens/W.
  - » Developing a construction waste management plan, including a dedicated collection area for recycling.
  - » Including options in construction contracting for materials reuse (salvaged, refurbished, etc.), recycled content (concrete aggregate, etc.), regional materials (originating within 500 miles of site), rapidly renewable materials, certified wood, biobased materials (for coatings, paints, lubricants), and environmentally preferred materials (sealants, caulks, paints, coatings free of ozone depleting compounds).

Conclusions

- Contracting clause to encourage sustainable practices
- Prepare an energy baseline to evaluate power use and GHG emissions
- Optimize energy efficiency, thinking beyond high-efficiency pumps
    - » Push back on the status quo
    - » Consider each process in the treatment train
- Evaluate renewable options
    - » PWP pressure reducing station designed to lose energy, had not considered in-line microturbines
    - » PV is currently more expensive than standard power, but PWP has invested $300K to make it happen at Windsor Reservoir as a result or NASA's efforts.
    - » Contact a PPA provider when evaluating PV
- Water Efficiency – Reduce volume of waste water and irrigation water
- Green Construction – Evaluating cost impacts
- Final decisions dependent upon how highly you value green principles.


NASA

Estimating Energy Usage - Optimized

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Well 52 Pump (200HP)	105.9	252	0.41M
Ventura Well Pump (150HP)	86.5	206	0.34M
Windsor Well Pump (250HP)	181.2	431	0.70M
Booster Pump No. 1 (250HP)	177.8	423	0.69M
Booster Pump No. 2 (250HP)	177.8	423	0.69M
Total	**818.7**	**1,949**	**3.18M**

Assumptions and Notes:

- 5,700 ac-ft of water treated per year at 7,000 gpm, resulting in 184 days of operation.
- Motor efficiency of 96% and a pump efficiency of 80%.
- GHG emission factor for electricity generation (zip code 91109) = 879 lbs CO_2/MWh.
- Average energy consumption for water treatment facilities is 1,700 to 1,900 kWh/MG.

Estimating Energy Cost - Optimized

Description	Total Sump ($/Year)	Total Wells ($/Year)
Customer/Meter Charge	$1,923	$2,891
Distribution Charge	$64,456	$83,942
Transmission Charge	$12,768	$16,575
Energy Service Charge		
Summer On-Peak (noon-8PM)	$25,134	$32,177
Summer Off-Peak (8PM to noon)	$46,708	$63,119
Winter On-Peak (6AM-10PM)	$17,112	$22,088
Winter Off-Peak (10PM-6AM)	$16,454	$21,696
Power Cost Adjustment	$15,920	$20,668
Public Benefit Charge	$13,214	$17,154
Annual Total ($493,998)	**$213,689**	**$280,309**

Assumptions and Notes:

- Utilizes current PWP rates (effective October 1, 2007) schedules L-1 and M-1.
- NASA pays energy costs for booster pumps, PWP pays energy costs for production wells.